MaGe and What Next

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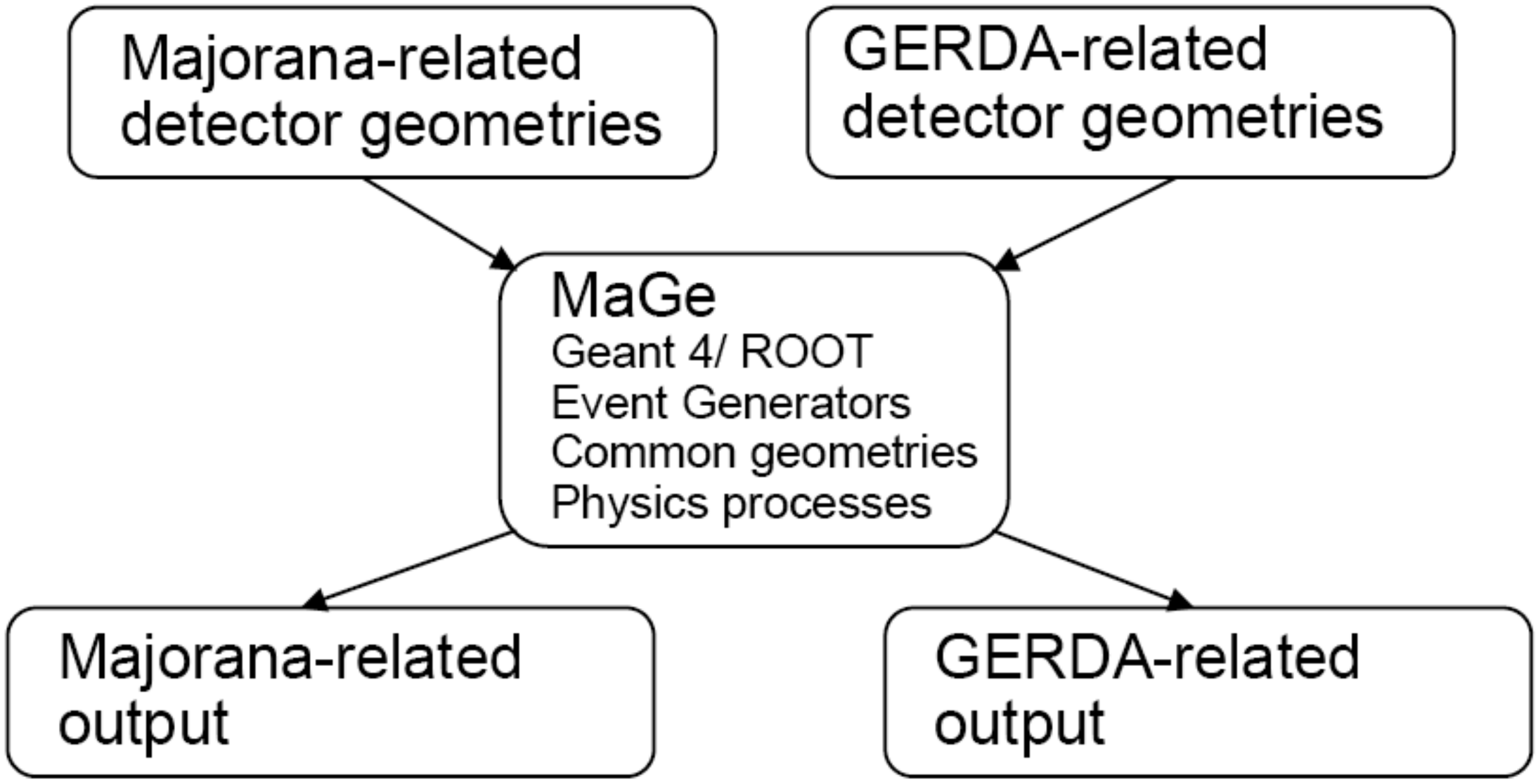
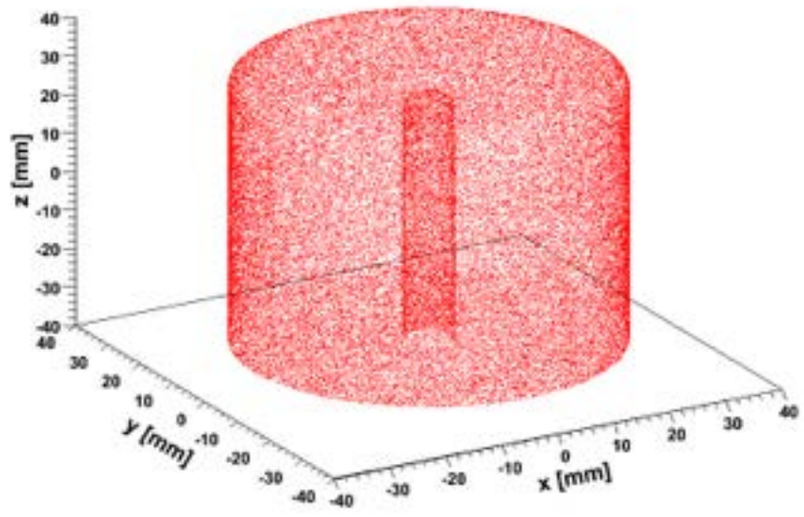
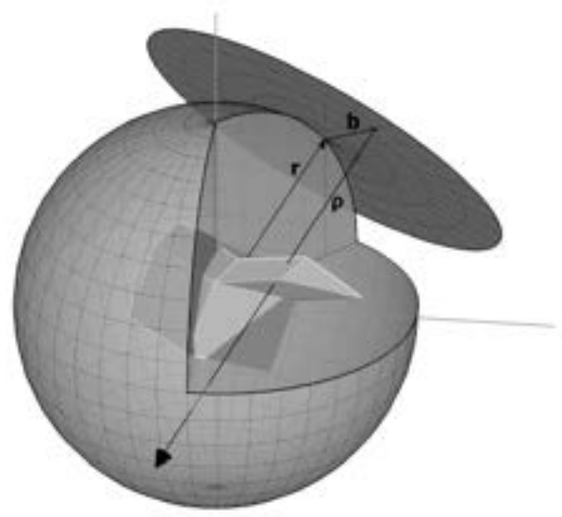
MaGe Concept



Some Features

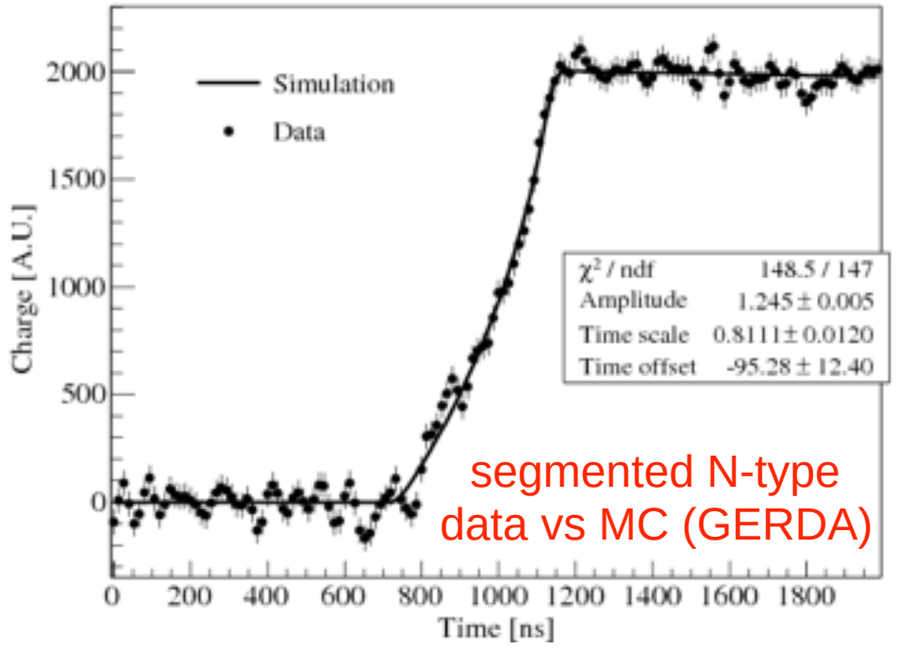
- General geometries
  - Crystals, boxes (e.g. lead), etc.
  - File-based geometry, GDML
- Generators
  - AmBe n, cosmic rays, spallation n, …
  - GPS, Generic Surface Sampler, file-based generators
  - Position sampling tools





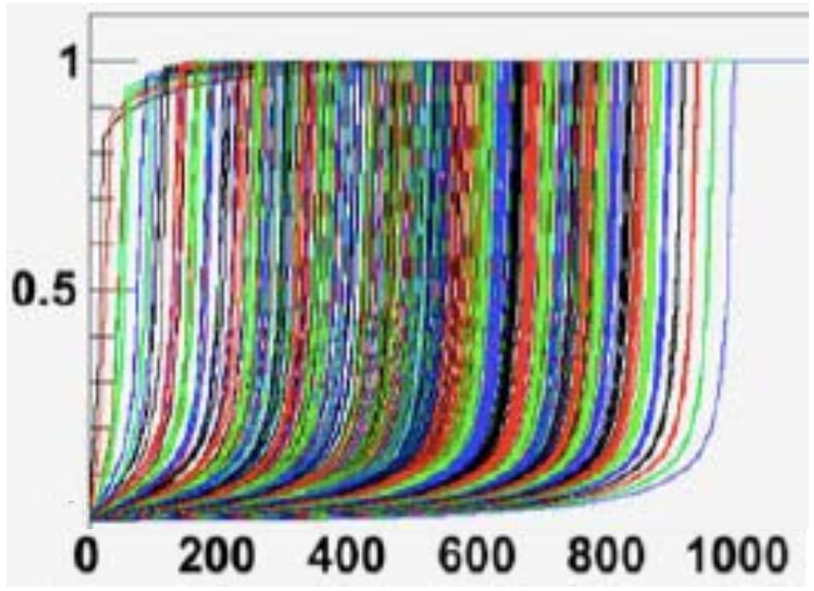
Some Features

- Low-level tools
  - seed control, event time windowing, importance sampling
- Generic IO
  - Steps data (using MGDO)
- Pulse shape simulation
  - Munich code, C++ implementation of old siggen



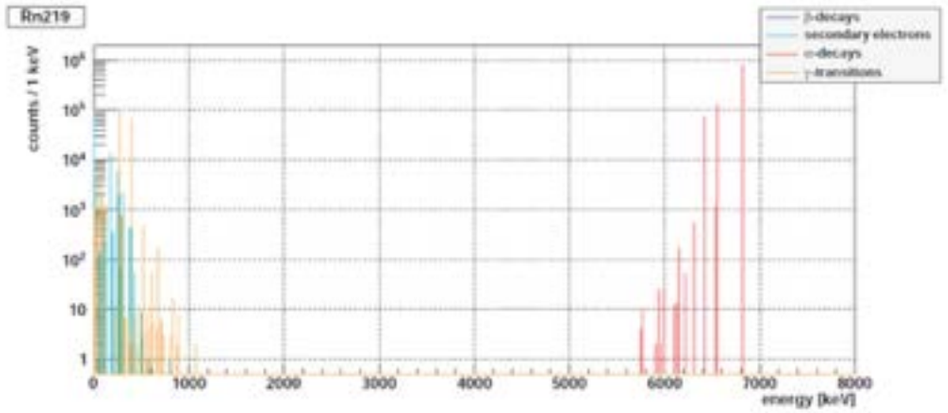
segmented N-type data vs MC (GERDA)

PPC pulse library (2mm grid)



Validation Suite

- Compare decay branches intensities, q-values, spectral shapes to ENSDF
- Checks on underlying interaction processes for γ, β, α, n...
- Numerical tests
- Comparative tests for software upgrades
- Generates a report



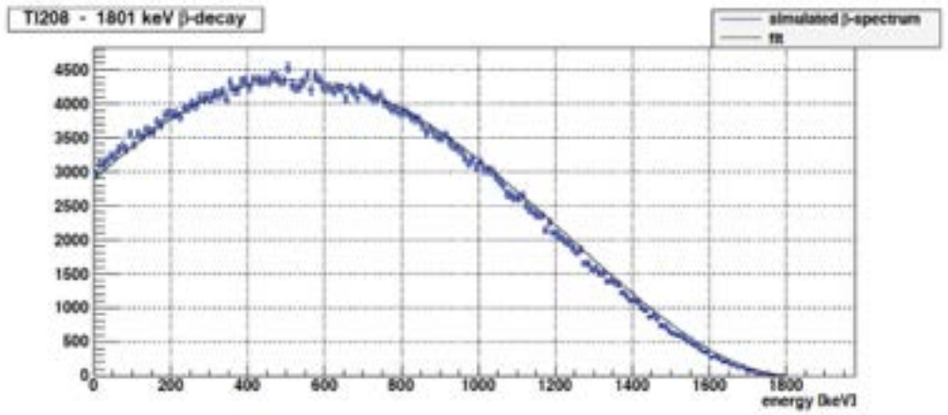


Table 11: ^{57}Co branching ratios, X-ray and γ-transition energies [1], [2]

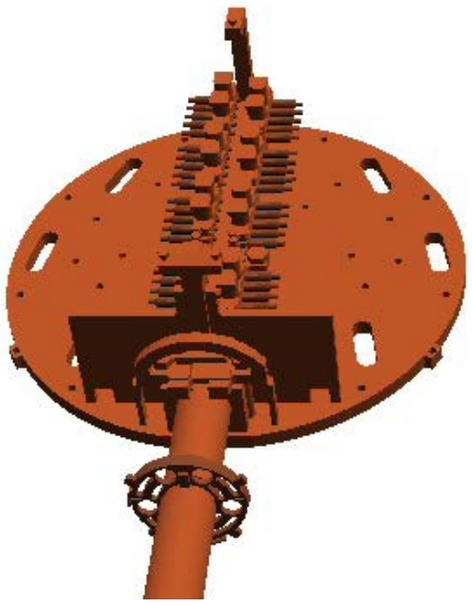
$E_{lit.}$ [keV]	$E_{sim.}$ [keV]	diff. [keV]	$I_{lit.}$ [%]	$I_{sim.}$ [%]	diff. [%]
6.4 ± 0.01	6.3628	-0.037	49.7 ± 1	32.3 ± 0.057	-17
7.06 ± 0.01	7.0706	0.011	5.91 ± 0.01	0.0024 ± 0.00049	-5.9
14.4129 ± 0.0006	14.413	0	9.16 ± 0.15	9.09 ± 0.03	-0.065
122.061 ± 0.00012	122.06	0.0024	85.6 ± 0.17	85.9 ± 0.093	0.33
136.474 ± 0.00029	136.47	0	10.68 ± 0.08	10.3 ± 0.032	-0.35
692.41 ± 0.07	692.35	-0.055	0.149 ± 0.01	0.143 ± 0.0038	-0.0064

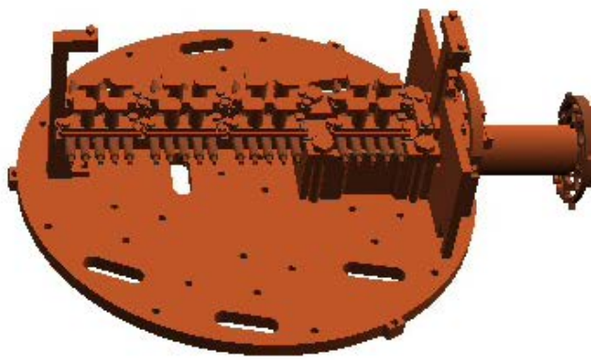
MJD MaGe

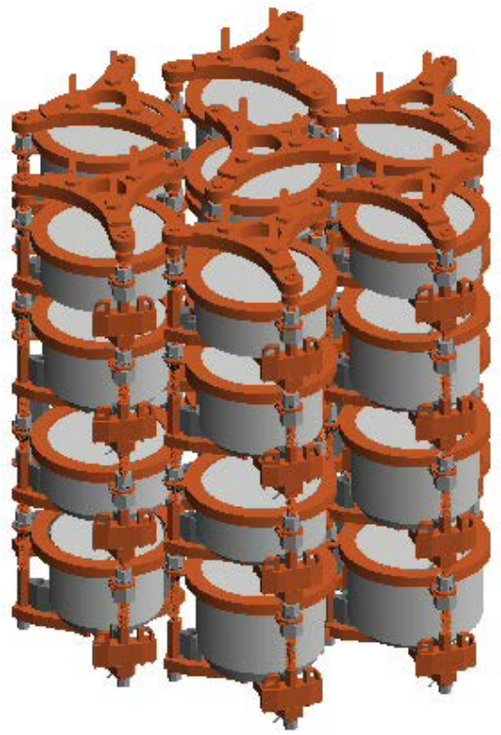
- Update for “as-built” geometries

Prototype Cryostat

Coldplates with crossarm and connector mount hardware



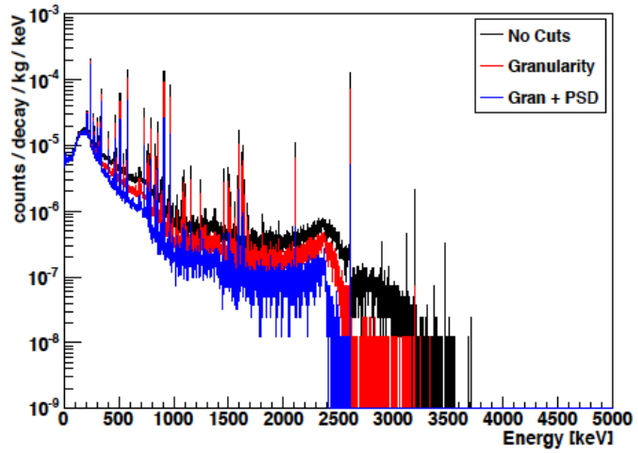


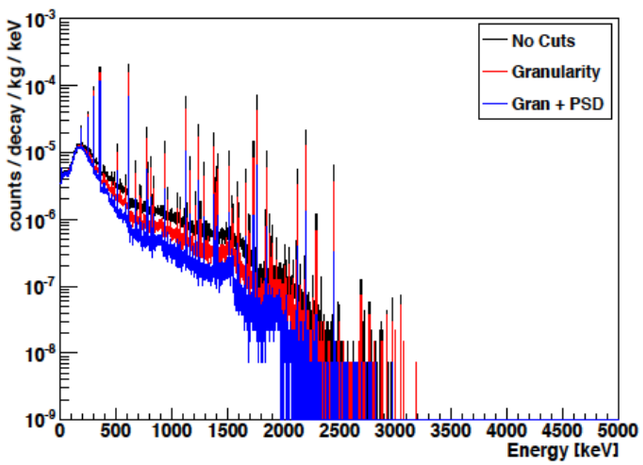


Module 1

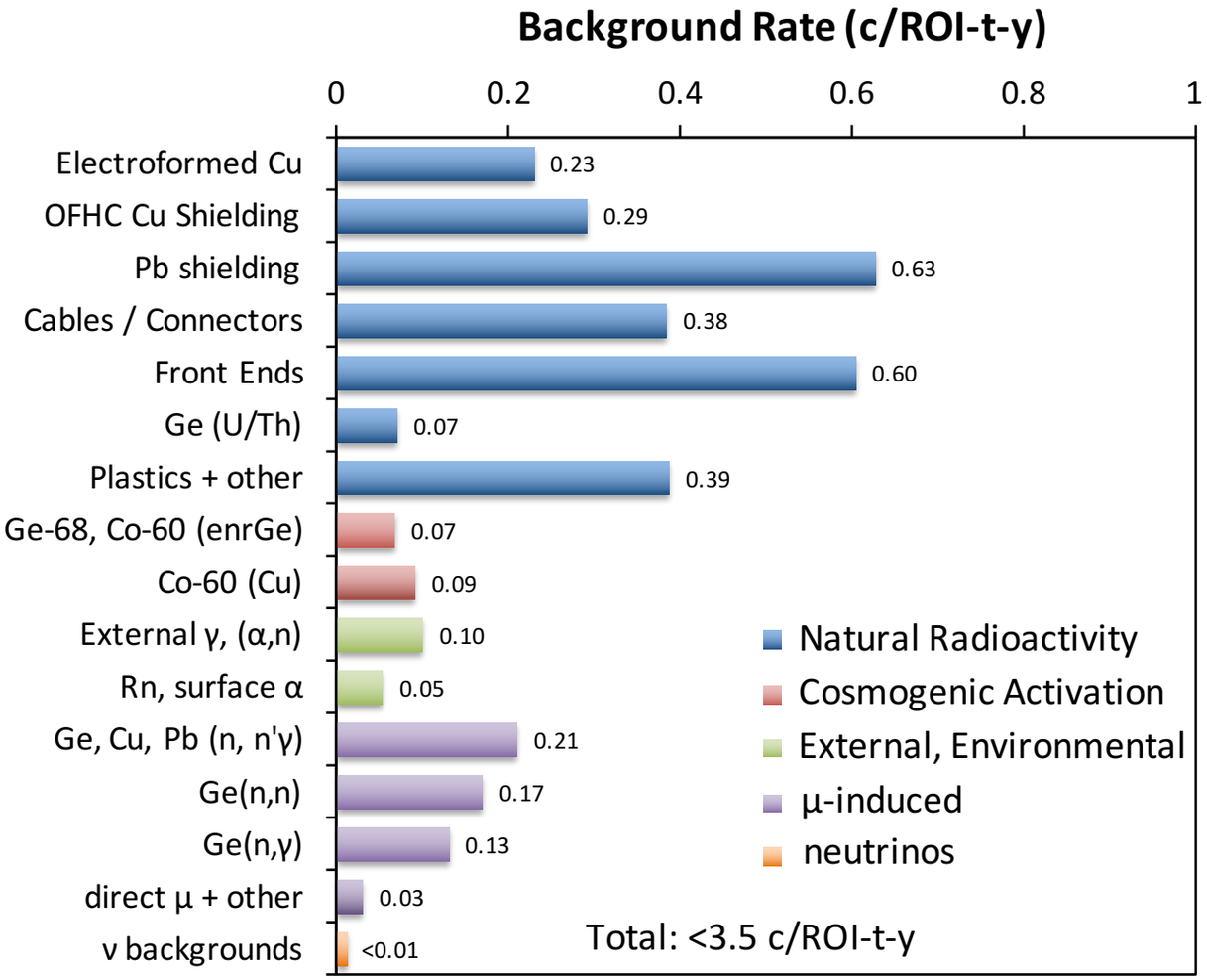
MAJORANA Updates

Currently running and summing simulations





Latest background budget:



Status of MaGe

- Distributed in private github repository
- In heavy use by MAJORANA and GERDA
  - Motivation to freeze new developments
- Still uses Geant4.9.6
  - Update to Geant4.10 should be possible but no one has had the time

MaGe-lite

- Agreement (I believe!) by both collaborations to allow access to a subset of MaGe called “MaGe-Lite”

- Spokespersons grant access to external parties at their own discretion and agreement, can go back to executive bodies if desired / necessary.

- All MAJORANA- and GERDA-specific code is removed

- Keep core infrastructure and general-use tools

What Next

(my wish list for “MaGe2”)

Disclaimer: I’m speaking for myself, not for MAJORANA or GERDA

Framework -> Toolkit

- MaGe is currently an executable into which all GERDA- and MAJORANA-specific code is built.

- Has its own infrastructure, built on top of G4's, for building geometries, generators, output, etc.

- Developers have to learn G4, then MaGe, to simulate a new detector

Framework -> Toolkit

- Move to a “toolkit” paradigm - code organized into classes and libraries that coders can build into their own executable or use in an interactive environment (e.g. python or cling)
- Have MaGe management code and derived classes work directly with G4 geometry and generator base classes already available for those purposes
    - G4LogicalVolume instead of MGGeometryDetector
    - G4VUserPrimaryGeneratorAction instead of MGVGenerator
- Provide tools that achieve common goals
- Toolkit allows groups to keep sensitive code in their own private repos that depend on MaGe2. Would make it possible to develop MaGe2 as open-source software.
- Contribute code that is generally useful directly to Geant4 and ROOT

MGDO / Generic Output

- Upgrade MGMCStepData (used by Majorana only) to work seamlessly with G4SensitiveVolumes
  - Collect steps in each sensitive volume
- Generates ROOT file of stepping information that can be analyzed directly or post-processed

Physics List + Validation Suite

- Update physics list with latest and greatest
- Build in capability to swap out for other named physics lists from the start
- Update validation suite and make it able to run out-of-the-box and give actionable results

Under the Hood

- We jumped through a lot of hoops to keep ROOT as an “optional” dependency / plug-in
  - Meant that much useful ROOT code was “off limits” for MaGe code.
  - Would like to assume use of ROOT (v6) from the start
  - CERN appears to want to continue to support it for the foreseeable future
- Use c++11 from the start, add boost dependency?
- Make MaGe2 multi-threading compliant from the start
  - Take advantage of new features in Geant4.10

Building

- Current method based on “old” Geant4 scheme is very buggy and complex
- (Not so) new tools available to make code that compiles like “normal” c++:
  - use geant4-config, root-config
  - provide mage-config for toolkit users

Post-Processing

- Majorana uses code in “GAT” (based on TAM) for:
  - Dead layers
  - Lindhard quenching
  - Detector resolution function smearing
  - Digitization time windowing and event multiplicity
  - PSD emulation (via “Δt heuristic”)
- Would be willing to contribute generic version of this code.

Pulse Shape Simulation

- Oliver is already planning to extract PSS code from MaGe into its own (public) git repo
- Radford's siggen is already publicly available
- Add plug-ins in post-processing suite for MaGe 2

DSP Libraries

- MGDO's MGWaveform has proved very useful
  - Generalize and contribute to ROOT?
- Many DSP routines in MGDO/Transforms and MGDO/GerdaTransforms
  - Contribute library of routines to ROOT?
  - Or make into a separate public repo

How To Get There

- Yue Qian has offered support from Tsinghua (Zhi Zeng, students)
- Luciano reminds us: “MaGe is formally the intellectual property of the GERDA and MAJORANA Collaborations, so any change involving the status, the scope and the ownership of MaGe will necessarily have to go through the GERDA Collaboration Board and MAJORANA Executive Council”